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Retzer et al.

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[54] METHOD OF AND APPARATUS FOR OPERATING A CELLULAR PHONE IN ONE OF TWO MODES

[75] Inventors: **Michael Herbert Retzer**, Palatine; **Manohar Achyut Joglekar**, Long Grove, both of Ill.

[73] Assignee: **Motorola, Inc.**, Schaumburg, Ill.

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[22] Filed: **Feb. 1, 1995**

[51] **Int. Cl.**[6] **H04Q 7/32**

[52] **U.S. Cl.** **455/434**; 455/466; 455/515; 455/553

[58] **Field of Search** 375/219, 222, 375/223, 305, 274, 336, 224; 455/426, 552, 553, 432, 434, 435, 515, 38.1, 343, 574, 556, 557, 181.1, 458, 186.1, 332, 466, 404; 370/493, 494, 495

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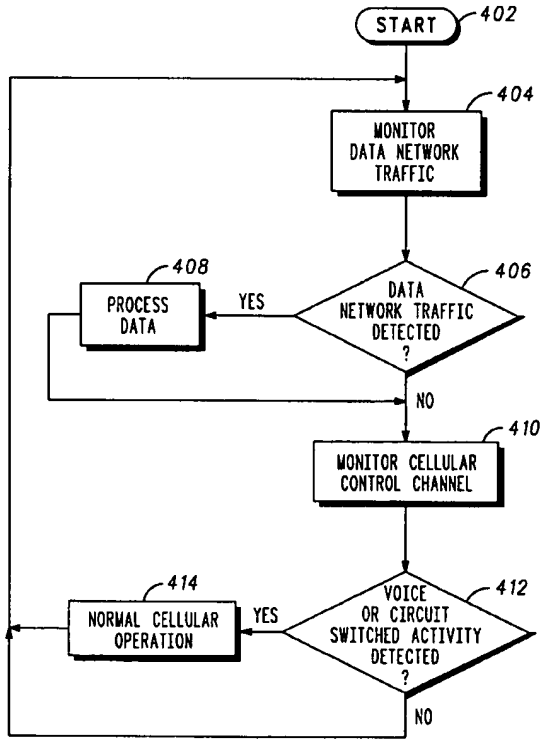
Primary Examiner—Reinhard J. Eisenzopf
Assistant Examiner—Lester G. Kincaid
Attorney, Agent, or Firm—John J. King; Daniel R. Collopy

[57] **ABSTRACT**

A unique method and apparatus automatically switches between a voice mode and a data mode in a wireless communication device. In particular, a communication device (**200**) adapted to voice and data signals monitors a data network for data traffic for a first predetermined period of time (**506**), then monitors a cellular control channel (**516**) for cellular traffic during a sleep mode of the data network before establishing normal cellular operation. The method and apparatus increases efficient use of channel capacity by selectively switching between systems during periods of nonuse. Finally, according to other novel aspects of the present invention, user prompts (**606, 618**) enable efficient use of a communication device capable of transmitting and receiving both voice and data.

11 Claims, 5 Drawing Sheets



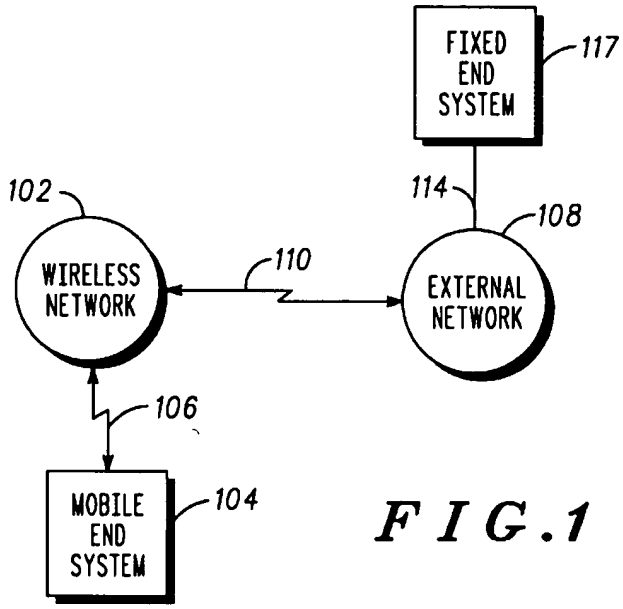

FIXED END SYSTEM
117
114
108
102
WIRELESS NETWORK
110
EXTERNAL NETWORK
106
MOBILE END SYSTEM
104

FIG. 1

FIG. 2

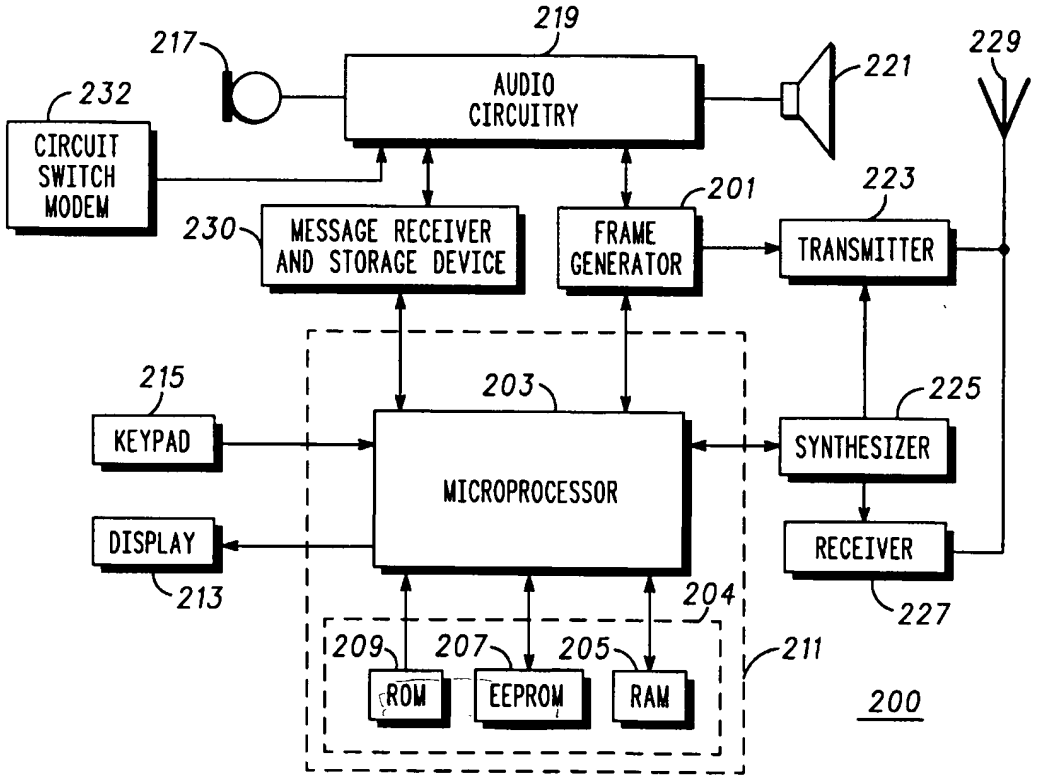
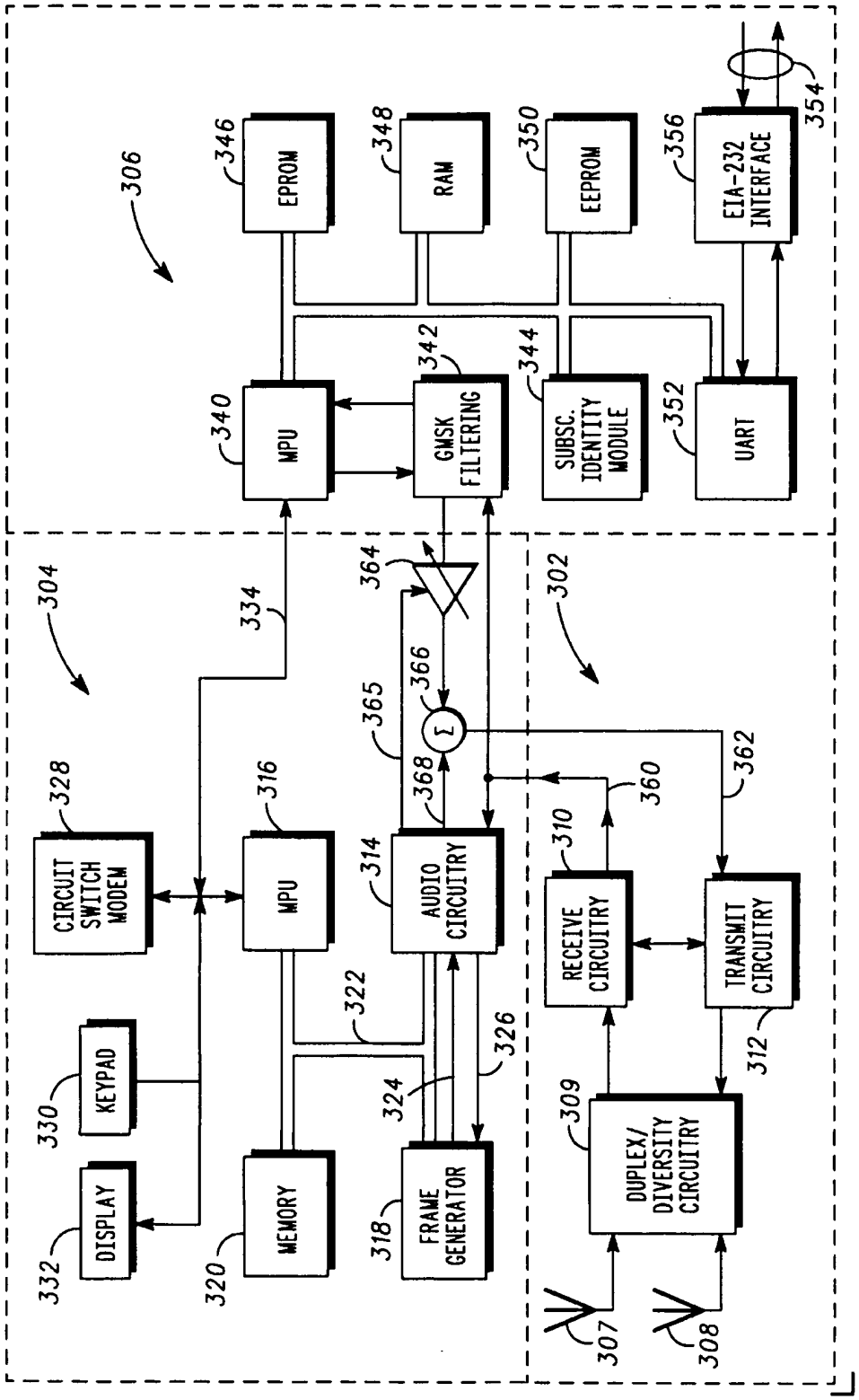

219
217
AUDIO CIRCUITRY
221
229
232
CIRCUIT SWITCH MODEM
201
223
230
MESSAGE RECEIVER AND STORAGE DEVICE
FRAME GENERATOR
TRANSMITTER
215
203
225
KEYPAD
MICROPROCESSOR
SYNTHESIZER
DISPLAY
RECEIVER
213
227
204
209
207
205
211
ROM
EEPROM
RAM
200

FIG. 3


306
346
EPROM
348
RAM
350
EEPROM
356
EIA-232 INTERFACE
354
340
MPU
342
GMSK FILTERING
344
SUBSC. IDENTITY MODULE
352
UART
304
334
364
302
366
365
368
362
360
328
CIRCUIT SWITCH MODEM
316
MPU
314
AUDIO CIRCUITRY
310
RECEIVE CIRCUITRY
TRANSMIT CIRCUITRY
322
326
330
KEYPAD
324
312
309
DUPLEX/ DIVERSITY CIRCUITRY
332
DISPLAY
320
MEMORY
318
FRAME GENERATOR
307
308

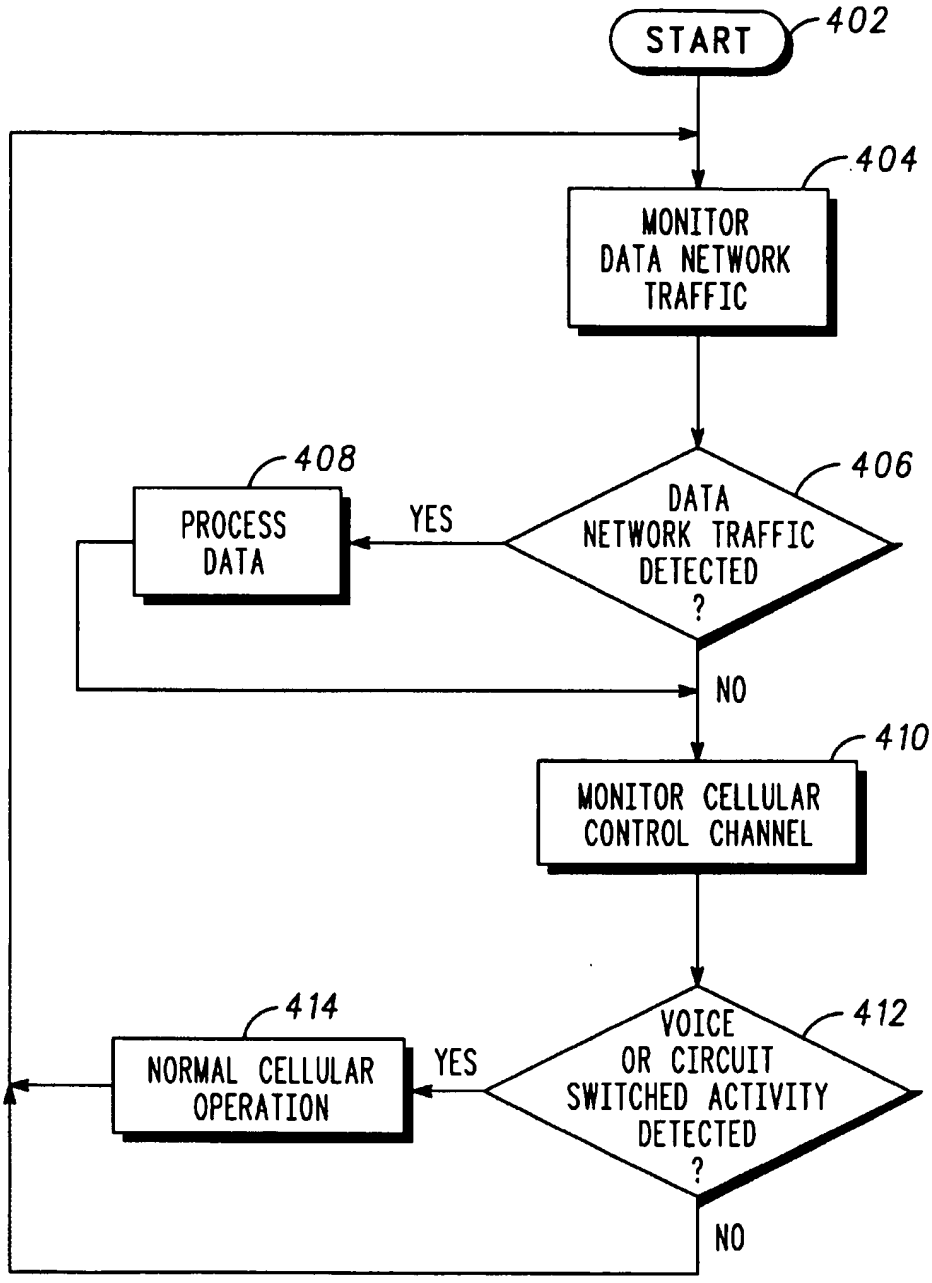

START
402
404
MONITOR DATA NETWORK TRAFFIC
406
DATA NETWORK TRAFFIC DETECTED ?
YES
408
PROCESS DATA
NO
410
MONITOR CELLULAR CONTROL CHANNEL
412
VOICE OR CIRCUIT SWITCHED ACTIVITY DETECTED ?
YES
414
NORMAL CELLULAR OPERATION
NO

FIG. 4

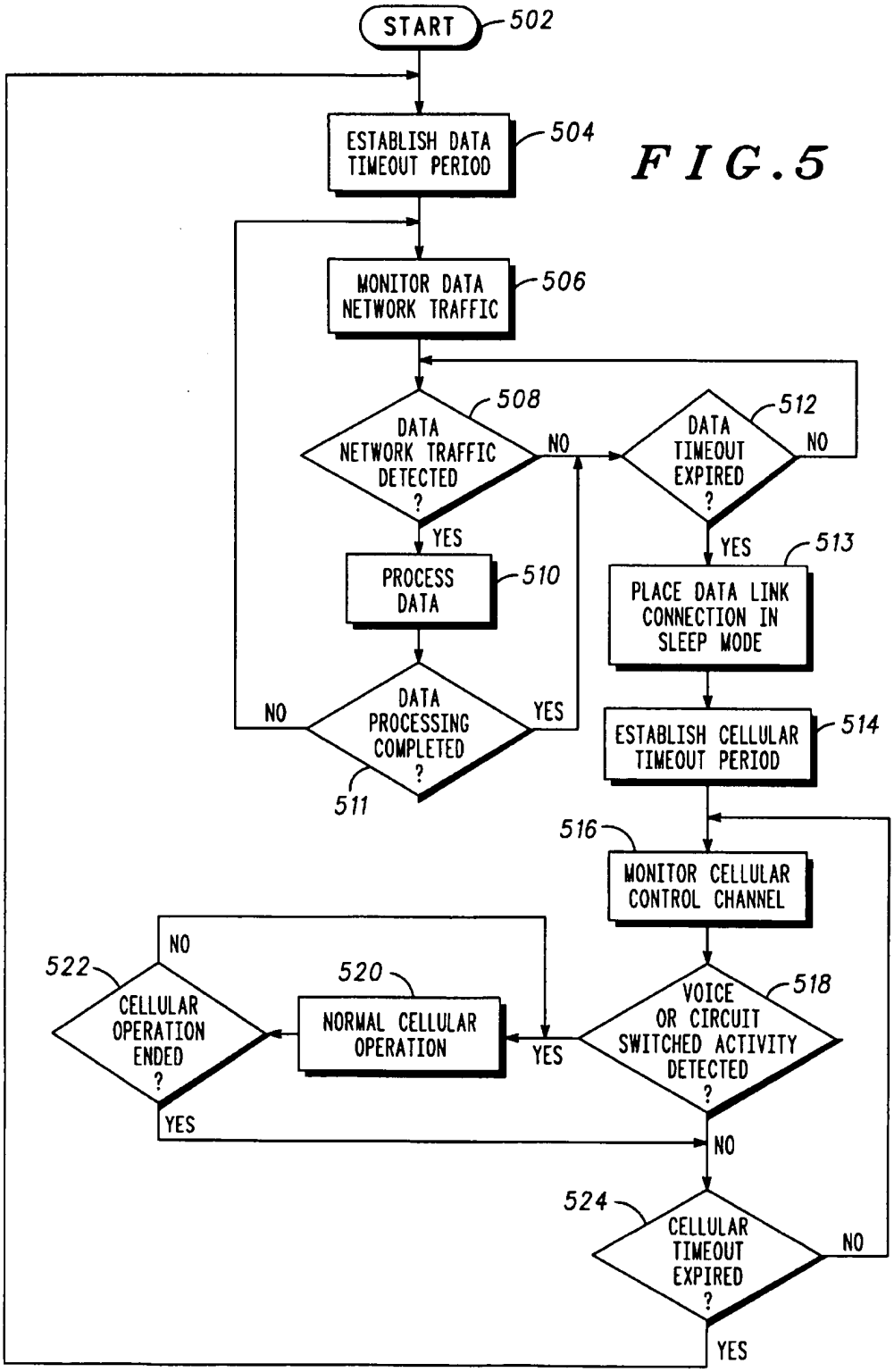

START
502
ESTABLISH DATA TIMEOUT PERIOD
504
MONITOR DATA NETWORK TRAFFIC
506
DATA NETWORK TRAFFIC DETECTED ?
508
NO
YES
PROCESS DATA
510
DATA PROCESSING COMPLETED ?
511
NO
YES
DATA TIMEOUT EXPIRED ?
512
NO
YES
PLACE DATA LINK CONNECTION IN SLEEP MODE
513
ESTABLISH CELLULAR TIMEOUT PERIOD
514
MONITOR CELLULAR CONTROL CHANNEL
516
VOICE OR CIRCUIT SWITCHED ACTIVITY DETECTED ?
518
YES
NORMAL CELLULAR OPERATION
520
CELLULAR OPERATION ENDED ?
522
NO
YES
NO
CELLULAR TIMEOUT EXPIRED ?
524
NO
YES

FIG. 5

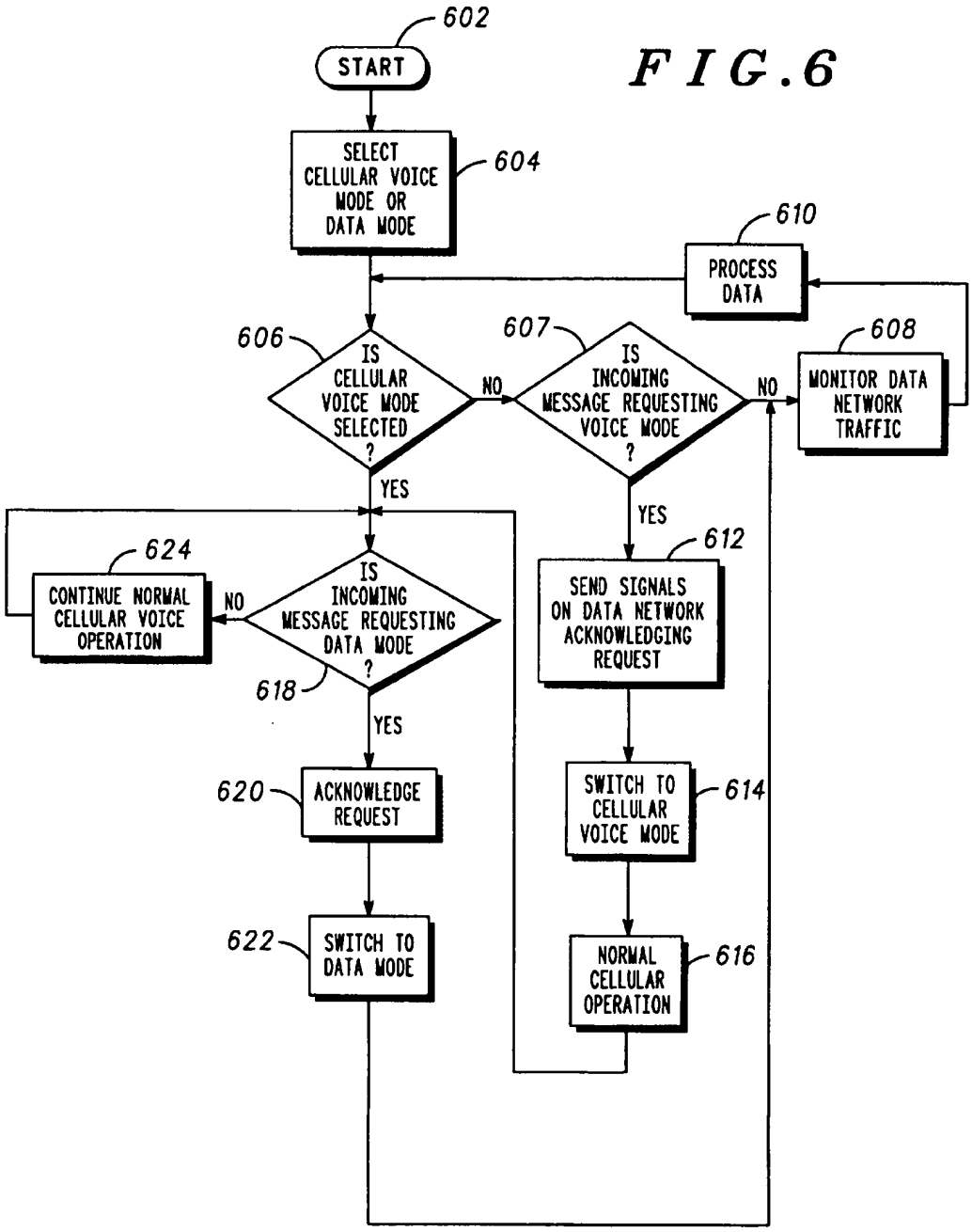

602
START
SELECT CELLULAR VOICE MODE OR DATA MODE
604
610
PROCESS DATA
606
IS CELLULAR VOICE MODE SELECTED ?
NO
607
IS INCOMING MESSAGE REQUESTING VOICE MODE ?
NO
608
MONITOR DATA NETWORK TRAFFIC
YES
YES
624
CONTINUE NORMAL CELLULAR VOICE OPERATION
NO
IS INCOMING MESSAGE REQUESTING DATA MODE ?
618
612
SEND SIGNALS ON DATA NETWORK ACKNOWLEDGING REQUEST
YES
620
ACKNOWLEDGE REQUEST
SWITCH TO CELLULAR VOICE MODE
614
622
SWITCH TO DATA MODE
NORMAL CELLULAR OPERATION
616

FIG. 6

METHOD OF AND APPARATUS FOR OPERATING A CELLULAR PHONE IN ONE OF TWO MODES

FIELD OF THE INVENTION

This application is related to communication systems, and more particularly to a method and apparatus for processing voice and data.

BACKGROUND OF THE INVENTION

The use of wireless communication devices has increased dramatically in recent years. With the increased number of subscribers for wireless communication services, channel availability has become scarce. Considerable effort has been made to increase channel capacity to meet the increased demand. While channel availability has reached capacity at peak periods during which many subscribers occupy channels, excess channel capacity typically exists at off-peak periods, or during other periods of non-use, such as during a handoff.

In response to the excess channel capacity during offpeak periods, systems have been considered for transmitting packet data. One such system is the Cellular Digital Packet Data (CDPD) network contemplated by a number of cellular service providers as set forth in the Cellular Digital Packet Data System Specification, Release 1.0, Jul. 19, 1993 or Release 1.1, Jan. 19, 1995, available from the CDPD Industry Input Coordinator, 650 Town Center Drive, Suite 820, Costa Mesa, Calif. 92626.

Presently, data packets transmitted on a CDPD network are transmitted by way dedicated data equipment, such a stand alone CDPD equipment. While conventional communication devices, such as cellular subscriber equipment, could be modified to include circuitry for transmitting data packets, such communication devices must have a means for switching between the two modes of operation. This could be achieved by having a physical switch or a user selectable mode of operation in the communication device for communicating on a cellular network or transmitting data on a data network. However, such manual switching or selection by the user is not only inconvenient, but also has performance limitations. That is, manual switching does not take advantage of dormant periods of operation in a data network.

Accordingly, there is a need for a method and apparatus for selectively switching between systems of the communication device to efficiently utilize channel capacity. There is a further need for a method and apparatus which automatically switches between the transmission of data packets and transmission of voice signals in cellular communication. Finally, there is a need for providing user prompts to enable efficient use of a communication device capable of transmitting and receiving both voice and data.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a network for transmitting signals and data between wireless communication systems and fixed end systems incorporating a mobile end system of the present invention;

FIG. **2** is a block diagram of a wireless communication device having digital packet data capability according to the present invention;

FIG. **3** is a detailed block diagram of the wireless communication device shown in FIG. **2**;

FIG. **4** is a flow chart showing a method for operating the wireless communication device of FIG. **3**; and

FIG. **5** is a detailed flow chart showing the operation of the wireless communication device of FIG. **3**.

FIG. **6** is a flow chart showing additional features of a communication device adapted to process voice and data.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Wireless communication systems have not only increased in popularity, but also in functionality. In addition to voice communication capability, wireless communication devices can transmit data messages by way of data packets. Excess channel capacity on existing cellular telephone systems provides a convenient opportunity for data packet transmission. The method and apparatus of the present invention automatically switches between the transmission of data packets and transmission of voice signals in cellular communication. In particular, the method and apparatus increases efficient use of channel capacity by selectively switching between systems during periods of non-use. Finally, according to other novel aspects of the present invention, user prompts enable efficient use of a communication device capable of transmitting and receiving both voice and data.

Turning first to FIG. **1**, a communication network **100** for incorporating the mobile end system of the present invention is shown. The communication network is adapted to transmit data and other signals between wireless networks, such as a cellular telephone network, and conventional landline networks, such a public system telephone network (PSTN) coupled to a computer network. In particular, a wireless network **102** is shown coupled to receive radio frequency (RF) signals from a mobile end system **104**, such as a mobile or portable cellular radiotelephone or other wireless communication device, by way of an RF link **106**. The wireless network **102** is also coupled to an external network **108**, such as a public system telephone network by way of a communication link **110**. The communication link could be a wireless link, or could be provided by a physical connection between the wireless network and the external network. The external networks are coupled to a fixed end system by way of existing infrastructure.

While the communication network of FIG. **1** shows the transmission of signals between a mobile end system and fixed end system by way of example, the present invention could also apply to communication between two mobile end systems coupled to the wireless network, for example. The present invention also could be employed in any wireless communication environment, such as paging, Personal Communication Services (PCS) or satellite communication services.

Turning now to FIG. **2**, a block diagram of a wireless communication device such as a cellular radiotelephone incorporating the present invention is shown. In the preferred embodiment, a frame generator ASIC (Application Specific Integrated Circuit) **201**, such as a CMOS ASIC available from Motorola, Inc. and a microprocessor **203**, such as a 68HC11 microprocessor also available from Motorola, Inc., combine to generate the necessary communication protocol for operating in a cellular system. Microprocessor **203** uses RAM **205**, EEPROM **207**, and ROM **209**, preferably consolidated in one package **211**, to execute the steps necessary to generate the protocol and to perform other functions for the communication unit, such as writing to a display **213**, accepting information from a keypad **215**, and controlling a frequency synthesizer **225**. ASIC **201** processes audio transformed by audio circuitry **219** from a

microphone **217** and to a speaker **221**. A transceiver processes the radio frequency signals. In particular, a transmitter **223** transmits through an antenna **229** using carrier frequencies produced by a frequency synthesizer **225**. Information received by the communication device's antenna **229** enters receiver **227** which demodulates the symbols comprising the message frame using the carrier frequencies from frequency synthesizer **225**.

The communication device may optionally include a message receiver and storage device including digital signal processing means. The message receiver and storage device could be, for example, a digital answering machine or a paging receiver. Finally, the communication device may include a circuit switch modem **232**. Circuit switch modems are well known to those skilled in the art of telecommunications.

Turning now to FIG. **3**, a detailed block diagram of a wireless communication device incorporating the present invention is shown. The wireless communication device includes radio frequency (RF) circuitry **302**, logic or control circuitry **304**, and modulation/demodulation (modem) circuitry **306**. RF circuitry **302** includes antennae **307** and **308** which are coupled to duplex/diversity circuitry **309**. Duplex/diversity circuitry **309** is coupled to receive circuitry **310** to couple signals to logic circuitry **304** or modem circuitry **306**. Duplex/diversity circuitry **309** is also coupled to transmit circuitry **312** for receiving signals from logic circuitry **304** or modem circuitry **306**. Transmit circuitry **312** couples these signals to the duplex/diversity circuitry **309** for transmission by way of one of the antennae **307** or **308**.

Logic circuitry **304** includes audio circuitry **314**, microprocessor **316**, frame generator **318** and memory **320**. These elements of logic circuitry **304** are interconnected via a logic bus **322**. The frame generator and the audio circuitry are also connected via lines **324** and **326**. Finally, the microprocessor is also coupled to circuit switch modem **328**, keypad **330**, and display **332** by bus **334**.

Data packet circuitry **306** comprises a microprocessor **340**, GMSK filtering circuitry **342**, a Subscriber Identity Module (SIM) **344**, and memory elements including an EPROM **346**, a RAM **348**, and an EEPROM **350**. Microprocessor **340** can communicate with microprocessor **203** of the logic circuitry by way of a high speed serial bus. A UART **352** enables communication with an external port **354** by way of an EIA-232 interface **356**. Receive circuitry **310** transmits signals to the audio circuitry **314** and modem circuitry **306** by way of line **360**. Transmit circuitry **312** receives signals from audio circuitry **306** and from modem circuitry **306** by way of line **362**. An attenuator **364**, which is controlled by the audio circuitry **314** by way of line **365**, attenuates signals from modem circuitry **310** to be transmitted to transmit circuitry **312** by way of a summing circuit **366**. Alternatively, attenuator circuit **364** could be a switch which blocks signals from modem **306**. Also, a second switch could be inserted in a line **368** to block signals from audio circuitry **314**, or a single switch could be employed to select signals from either the logic circuitry or the modem circuitry. Summing circuit **366** enables signals from both logic circuitry **304** and modem circuit **306** to be sent to transmit circuitry **312**.

When transmitting signals from the logic circuitry to the RF circuitry, signals from the modem are attenuated by attenuator **364**. Therefore, when the signals from modem **306** are attenuated, signals from summary circuit **366** on line **362** comprise signals only from the logic circuitry. When transmitting signals from modem circuit **306**, audio circuitry **314** mutes any audio signals from logic circuitry **304**, and minimizes attenuation from the modem. Therefore, signals from summary circuit **366** on line **362** comprise signals only from the modem.

The block diagram of the circuit of FIG. **3** includes RF circuitry **302**, logic circuitry **304** and modem circuitry **306** partitioned as modules. Such partitions are merely shown by way of example, and are not intended as limitations of the present invention. Elements of one module could be placed in another module, redundant elements could be eliminated, or the modules could be combined into a single module. For example, a single microprocessor could replace microprocessors **316** and **340**. Although attenuator **364** is shown as a part of logic circuit **304**, attenuator **368** could be incorporated in modem **306**. Finally, attenuator **364** and summary circuit **366** could be replaced by separate lines form each of audio circuitry **314** and GMSK modulator/demodulator circuitry **342** to receive circuitry **310** and transmit circuitry **312**. Other modifications to the circuit of FIG. **3** could be made within the spirit and scope of the present invention.

Turning now to FIG. **4**, a flow chart shows a method for operating the wireless communication device of FIG. **2**. The communication device monitors data network traffic at step **404**, and determines whether data network traffic is detected at step **406**. If data is detected, the data is processed at a step **408**. After processing the data, or if no data is detected, the communication device monitors cellular control channels at a step **410**. At a step **412**, it is determined whether voice or circuit switched activity is detected. If activity is detected, normal cellular operation takes place at a step **414**. If no activity is detected or after normal cellular operation, the communication device monitors data network traffic at step **404**.

Turning now to FIG. **5**, a more detailed flow chart shows additional novel features for operating the wireless communication device of FIG. **2** according to the present invention. At step **502**, a data link connection is established between the communication device and the data network. At a step **504**, the communication device establishes a data timeout. Such a data time-out can be employed in data networks having an optional sleep mode. A sleep mode is intended to assist power conservation by disabling or powering down a receiver and its associated circuitry. The sleep mode option may be requested by the communication device during data link establishment. The sleep mode procedures of the CDPD network, for example, can be found in Section 6.8 of the earlier cited CDPD Specification, Release 1.1 (Jan. 19, 1995).

The communication device then monitors data network traffic at a step **506**. At a step **508**, the communication device determines whether data network traffic is detected. If data network traffic is detected, the data is processed at a step **510**. The network device then determines whether the processing is completed at a step **511**. If the processing is not completed, the communication device monitors data traffic at step **506**. If no data traffic is detected, or if the processing is completed, the communication device determines whether the data time-out has expired at step **512**. If the time-out has not expired, the communication device determines whether data network traffic is again detected at step **508**.

When the data time-out expires at **512**, the data link connection is placed in a sleep mode and the communication device establishes a cellular time-out at a step **514**. The cellular time-out represents the duration of this sleep mode of the data network. Because no data will be received when the data link is placed in a sleep mode, the communication

device automatically monitors the cellular control channel at a step **516**. The communication device determines whether voice or circuit switch modem activity is detected at a step **518**. If activity is detected, normal cellular operation takes place at step **520**. The communication device determines whether the cellular operation has ended at a step **522**. Because data transmission can be transmitted periodically, cellular operation preferably takes priority over any data operations. After normal cellular operation has ended, the communication device determines whether the cellular time-out has expired at a step **524**. If the cellular time-out has not expired, the communication device monitors cellular control channel at step **516**. If the cellular time-out has expired at step **524**, the communication device establishes a data time-out at step **504** and monitors data network traffic at step **506**.

Turning now to FIG. **6**, a flow chart shows additional features of a communication device adapted to process voice and data. Because some users of a device may rely more heavily on either voice or data, it may beneficial to select one mode and remain in that mode. However, selecting a single mode will preclude receiving a message in the other mode. The method of FIG. **6** provides greater flexibility for a user to select a certain mode and receive an alert in the selected mode that a message is ready to be transmitted in the other mode.

In particular, at a step **604**, the user selects the cellular voice mode or a data mode, such as CDPD data mode. At a step **606**, the communication device determines whether the cellular voice mode is selected. If the cellular voice mode is not selected, the data mode is selected and the communication device determines whether the incoming data message requests the voice mode at a step **606**. If the data message does not request the voice mode, the communication device continues to monitor network traffic at a step **608** and processes any data at step **610**. If the incoming message requests the voice mode at a step **606**, the user sends a signal on the data network acknowledging the request at a step **612**. The user than switches to the cellular voice mode at a step **614** for normal cellular operation at a step **616**.

If the cellular voice mode is selected at step **606**, the user determines whether an incoming message requesting the data mode is received. Such a message could be sent as an overhead message and output on the display of the communication device, or some other audible or visual display. If no message is received at step **618**, the user continues normal cellular voice operation at step **624**. If the user receives a request for the data mode, the user acknowledges the request at a step **620** and switches to the data mode at step **622**. In addition to application to CDPD, the methods of FIG. **6** could also be employed on other cellular data networks, such as the NAMPS system. The NAMPS system is well known in the art and supports short messaging capability. Also, for two line capability, a user could place a voice call on hold to receive a data message rather than terminating the voice call.

In summary, excess channel capacity on existing cellular telephone systems, at off-peak periods, or during other periods of channel non-use, such as during a handoff, provides a convenient opportunity for data packet transmission. The method and apparatus of the present invention automatically switches between transmission of voice signals and the transmission of data packets. In particular, the method and apparatus increases efficient use of channel capacity by selectively switching between systems during periods of non-use. Finally, according to other novel aspects of the present invention, user prompts enable efficient use of a communication device capable of transmitting and receiving both voice and data signals. While the specific implementations of the present invention are described above, variations and modifications could be made by one skilled in the art within the spirit and scope of the present invention. The present invention should be limited only by the appended claims.

We claim:

1. A method for operating a wireless communication device adapted to operate in one of two modes, said method comprising the steps of:

monitoring a data network for data traffic during a first predetermined period of time;

determining during said first predetermined period of time whether any data traffic is detected;

processing data when data traffic is detected during said first predetermined period of time;

monitoring a cellular control channel for cellular traffic during a second predetermined period of time after processing data or when no data traffic is detected during said first predetermined period of time;

determining during said second predetermined period of time whether any cellular traffic is detected; and

establishing normal cellular operation when cellular traffic is detected; and

monitoring said data network during said first predetermined period if no cellular traffic is detected.

2. The method for operating a wireless communication device according to claim **1** further comprising a step of establishing a data link connection between said wireless communication device and a data network.

3. The method for operating a wireless communication device according to claim **2** further comprising a step of placing said data link connection in a sleep mode at the end of said first predetermined period of time.

4. The method for operating a wireless communication device according to claim **1** wherein said step of processing data comprises modulating and demodulating data using GMSK modulation.

5. The method for operating a wireless communication device according to claim **1** wherein said step of establishing normal cellular operation comprises continuing normal cellular operation until said normal cellular operation is terminated.

6. The method for operating a wireless communication device according to claim **5** further including a step of monitoring said data network after said normal cellular operation is terminated.

7. A method for operating a wireless communication device adapted to operate in a voice mode and a data mode, said method comprising the steps of:

establishing a data link connection between said wireless communication device and a data network;

monitoring a data network for data traffic during a first predetermined period of time;

determining during said first predetermined period of time whether any data traffic is detected;

processing data when data traffic is detected during said first predetermined period of time;

placing said data link connection in a sleep mode at the end of said first predetermined period of time;

monitoring a cellular control channel for cellular traffic during a second predetermined period of time after processing data or when no data traffic is detected during said first predetermined period of time;

determining during said second predetermined period of time whether any cellular traffic is detected;

establishing normal cellular communication when cellular traffic activity is detected; and

monitoring said data network during said first predetermined period if no cellular traffic is detected.

8. The method for operating a wireless communication device according to claim **7** wherein said step of processing data comprises modulating and demodulating data using GMSK modulation.

9. The method for operating a wireless communication device according to claim **7** further including a step of monitoring said data network after said normal cellular communication is terminated.

10. A method for operating a cellular radiotelephone adapted to transmit and receive communication signals in a first mode of operation, and transmit and receive data signals in second mode of operation, said method comprising the steps of:

monitoring a data network for said data signals during a first predetermined period;

determining during said first predetermined period whether any data signals are received;

processing said data signals when data signals are received during said first predetermined period;

monitoring a cellular control channel for said communication signals during a second predetermined period after processing said data signals or when no data signals are received during said first predetermined period;

performing normal cellular operation when said communication signals are received; and

monitoring said data network during said first predetermined period if no said communication signals are detected.

11. A method for operating a cellular radiotelephone adapted to operate in a voice mode and a cellular digital data packet mode, said method comprising the steps of:

establishing a data link connection between said cellular radiotelephone and a data network;

monitoring a data network for data traffic during a first predetermined period of time;

determining during said first predetermined period of time whether any data traffic is detected;

modulating and demodulating data when data traffic is detected during said first predetermined period of time using GMSK modulation;

placing said data link connection in a sleep mode at the end of said first predetermined period of time;

monitoring a cellular control channel for cellular traffic during a second predetermined period of time after modulating and demodulating data or when no data traffic is detected during said first predetermined period of time;

determining during said second predetermined period of time whether any cellular traffic is detected;

establishing normal cellular communication when cellular traffic is detected; and

monitoring said data network for data traffic during said first predetermined period of time after said normal cellular communication.

* * * * *